JC17 Rec'd PCT/PTO 21 JUN 2001

FORM PTO-1390 U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		713-258
		U.S. APPLICATION NO. (if known, see 37 CFR 1 5) 09/868842
INTERNATIONAL APPLICATION NO. PCT/US99/30521	INTERNATIONAL FILING DATE 22 December 1999 (22.12.1999)	PRIORITY DATE CLAIMED 22 December 1998 (22.12.1998)

TITLE OF INVENTION

SELF-BALANCING IONIZER MONITOR

APPLICANT(S) FOR DO/EO/US

Richard D. RODRIGO and William S. RICHIE, Jr.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☐ A English translation of the International Application into English (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto
   b. ☐ has been previously submitted under 35 U.S.C. 154 371 (c)(2)
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendment has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ A English translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 20. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821–1.825
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4)
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4)
20. ☒ Other items or information.
    a. PCT/IPEA/409 – International Preliminary Examination Report with 2 sheets of annexes

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U.S. APPLIC. NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
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21. ☒ The following fees are submitted:		CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)):			
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO	$ 1000.00		
International Search fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO and JPO	$ 860.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	$ 710.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)	$ 690.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) And all claims satisfied provisions of PCT Article 33(2)-(4)	$ 100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =		$ 860.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).		$ 0.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	10 - 20 =		X $18.00	$ 0.00	
Independent Claims	2 - 3 =		X $78.00	$ 0.00	
Multiple dependent claim(s) (if applicable)			+ $260.00	$ 0.00	
TOTAL OF ABOVE CALCULATIONS =				$ 860.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.				$ 0.00	
SUBTOTAL =				$ 860.00	
Processing fee of **$130.00** for furnishing the English translation later than the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).			+	$ 0.00	
TOTAL NATIONAL FEE =				$ 860.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property			+	$ 0.00	
TOTAL FEES ENCLOSED =				$ 860.00	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of $ XXX.XX to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. XXX in the amount of $ XXX to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 07-1337. A duplicate copy of this sheet is enclosed.

c. ☒ Fees are to be charged to a credit card **WARNING:** information on this form may be public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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REGISTRATION NUMBER

BASED ON FORM PTO-1390 (Rev. 5-93)

SELF-BALANCING IONIZER MONITOR

Related Applications

The present application claims priority of U.S. Provisional Application Serial No. 60/113,211, filed December 22, 1998, entitled "Self-Balancing Ionizer Monitor", the disclosure of which is incorporated by reference herein in its entirety.

Technical Field

This invention pertains to ion balance monitor methods and apparatus. The ion balance monitor monitors the ion output and ion balance of the ionizer and indicates the status of the ionizer to an operator. Such ion balance expedients are useful in controlling the desired balance or desired degree and type of imbalance of positive and negative ions in gas environments. More particularly, the invention is useful in connection with air blowers and charged electrode ion emitters as are used in controlling the ionization polarity in rooms or other spaces. Such control is useful in many fields, as in controlling the ionization of the air in clean rooms in which microchips are manufactured, as a single example.

Background Art

There is a need to monitor ionizers for (1) ion output and (2) ion balance. This is fairly easy to achieve with DC ionizers by monitoring the DC current due to ionization in the return of the power supply. It is more difficult to do with AC ionizers, especially of the self-balancing type, due to lack of return on power supply and the fact that AC ionization current is very

small as compared with other currents in the AC high voltage circuit.

Some prior attempts have been made to monitor the ion balance in an ionizer. Known attempts include U.S. Patent 4,477,263. This patent discloses a DC grid with a sensor system to monitor the balance. The balance is sensed in the room and is manually adjusted to a null meter reading on the controls.

U.S. Patent 4,630,167 discloses a plate sensor in the work area and an infrared link to control ion balance in a pulsed DC system having spaced apart emitters.

U.S. Patent 4,809,127 discloses a pulsed DC system of air ionizers. The ion current is sampled through a resistor and is used to regionally adjust the emitter output.

U.S. Patent 4,901,194 discloses sequenced positive and negative pulses. The ion current with an integrating feature maintains average ion conditions in the room and controls the pulse generators.

U.S. Patent 4,951,172 discloses a guarded sensor/control system. The sensor is a guarded probe placed in the work area.

There are of course many patents relating to ion balance. These include the following U.S. patents: 2,264,495; 2,879,395; 3,714,531; 4,423,462; 4,092,543; 3,936,698; 4,740,862; 4,757,422; 4,872,083; 5,008,594; 5,055,963; 5,153,811; 3,711,743; 4,435,195; 5,047,892; 5,057,966; 4,476,514; 4,528,612; 4,974,115; 4,542,434; 4,878,149; 4,642,728; 4,757,421; and 4,785,248.

Summary of the Invention

The monitor of the present invention senses the high voltage alternating current in the emitter and senses the reference circuits of the ionizer. The sensing circuits are capacitively coupled to the emitter and reference circuits. Faults may be detected and displayed on trip

alarm light emitting diode displays or by other output signals. The output signals may be used to automatically adjust the system by known means. Capacitive coupling used in this way is believed to be novel. The invention permits the monitoring function to be accomplished without interfering with the operation of the self-balancing circuit.

It is accordingly an object of the present invention to monitor ionizers for ion output and ion balance.

Another object is to monitor ionizers for ion output and balance in AC ionizers, particularly of the self-balancing type.

Still another object is to monitor high voltage and ion output and ion balance in self-balancing ionizers by sensing AC high voltage in both high voltage emitter and reference circuits.

There are certain typical, though rare, faults that adversely affect the ion balance. Faults that produce no ion output, such as a dead transformer, the emitter shorted to ground, or the emitter shorted to reference, etc., result in zero or very low AC voltage to ground in the emitter circuit. Faults that result in ion imbalance, such as the reference shorted to ground, result in a zero or very low AC voltage to ground in the reference circuit. In the present invention, the emitter and reference circuits are capacitively coupled with the sensing circuits whereby normal and abnormal operation are sensed without interfering with the function of the self-balancing circuit. This sensing is accomplished by performing a peak detection of the AC signal present on both the emitter and reference circuits, separately. These peak detected signals are then passed on to circuits with variable thresholds. The comparator circuits are used to trip alarm LEDs when the peak detector levels fall below the thresholds. Optional

output signals of any desired other kind can be derived from these processed signals by known conventional means.

Still other objects and advantages of the present invention will become readily apparent to those skilled in this art from the following detailed description, wherein only the preferred embodiments of the invention are shown and described, simply by way of illustration of the best mode contemplated of carrying out the invention. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, all without departing from the invention. Accordingly, the drawing and description are to be regarded as illustrative in nature, and not as restrictive.

Brief Description of Drawings

Fig. 1 is a schematic view of the overall ionizer apparatus showing the connections and relationships of the ion balance and ion output circuits.

Fig. 2 is a schematic view of the details of the ion balance and ion output monitor circuits.

Best Mode for Carrying out the Invention

The monitor according to the present invention operates by sensing the AC high voltage in the emitter and reference circuits of the ionizing assembly. Under normal conditions, the emitter circuit has approximately 3 KVAC (kilovolt alternating current) with respect to ground and the reference circuit has approximately 2 KVAC with respect to ground.

Existing monitoring circuits typically depend on measuring current due to ionization itself. This direct measurement typically results in connections between the ionizing circuit and ground through which net DC currents can flow. These connections to ground with net DC currents are incompatible with the operation of self-

balancing ionizers. The monitoring circuit of the present invention uses capacitors (either discrete components or via capacitive coupling) to block DC currents to ground.

The use of capacitive coupling to monitor a self-balancing ionizer's performance is a new expedient. Intrusive (directly connected) monitoring systems were incompatible with and would interfere with the operation of self-balancing ionizers The fact that the self-balancing ionizer uses AC enables the use of capacitive coupling to monitor the ionizer performance.

This circuit enables the monitoring of two aspects (ion output and ion balance) in self-balancing ionizers. The monitor does not affect the operation of the self-balancing circuit. The monitoring is performed in a cost effective manner. This circuit can provide ionizer operation status output for remote monitoring.

It has been found possible in the present invention to monitor high voltage (HV) ion output and ion balance on self-balancing ionizers by sensing the AC HV in both the HV (emitter) and reference circuits. Under normal conditions approximately 3 KVAC with respect to ground manifests itself in the HV (emitter) circuit and approximately 2 KVAC with respect to ground manifests itself in the reference circuit.

Typical faults for no ionization (dead transformer, or points shorted to ground) result in zero or very low AC voltage to ground in the HV (emitter) circuit. Typical faults for ion imbalance (reference shorted to ground) result in zero or very low AC voltage to ground in the reference circuit.

The present invention is able to monitor for these conditions as best initially shown in Fig. 1. This simple circuit provides monitoring of self-balancing ionizers without affecting the self-balancing function. An example of such a self-balancing ionizing circuit for

a static eliminator to which the present invention may be applied is shown in U.S. Patent 5,153,811. The high voltage transformer is generally designated 1. It comprises a primary winding 2, a core 3, and a secondary winding 4. The high voltage lead 5 connects one end to the secondary to the HV electrode emitter 8. The reference lead 6 connects to the other end of the secondary to the reference electrode 9.

A blower 7 propels a stream of air in the direction indicated by the arrow over the emitter 8, the reference electrode 9 and through the orifice 11 into the region to be treated. The electrodes are contained within an ionizing chamber 20. The orifice 20 is mounted on and the whole ionizing device is encased in case 10. The structure described above in connection with Figure 1 is conventional.

A high voltage capacitive pickup 18 is provided at the HV lead 5. An ion output sensing lead 20A connects capacitive pickup 18 to an ion output sensor generally designated 13. The ion output sensor 13 comprises a comparator 31 shown in simplified form and a LED alarm display 15.

A reference voltage capacitive pickup 19 is provided at the reference lead 6. An ion balance lead 21 connects capacitive pickup 19 to an ion balance sensor generally designated 14. The ion balance sensor 14 comprises a comparator 32 shown in simplified form and a LED alarm display 16.

The case 10 is provided with ground 12 and the comparators 31 and 32 are each provided with grounds 17, as shown in Figure 1. Each of the comparators may be a standard part LM339, though it is understood that the specification herein of a particular industry part number or description does not limit the invention, and functional equivalents for any of the specified components may be used as within the skill of the art.

The output sensors 13 and 14 are shown in more schematic detail in Figure 2. The upper portion of Figure 2 shows the ion output sensor 13 portion and the lower portion of Figure 2 shows the ion balance 14 portion. Like reference numerals and part designations in the upper and lower portions refer to like parts. As shown in Figure 1, the HV lead 5 is capacitively coupled 18 to lead 20A and the reference lead 6 is capacitively coupled 19 to lead 21. The signals from the capacitor couplings 18 and 19 are each amplified through a transistor 34 and 35 respectively, standard part MPS2222A, the outputs of which continue through diode 24, which is standard part 1N4002. Thereafter, each of the leads 36 and 37 is grounded through a 1 microfarad capacitor 25 and also each is grounded through a 1M Ohm resistor 26.

Continuing the path of each lead 36 and 37, each is connected to a + (positive) input of a comparator 31 and 32, respectively. A +5 volt source is connected through a 10K Ohm resistor and to ground through a variable 10K Ohm resistor 27 and thence to the - (negative) input of a comparator. The variable resistors are set to provide the desired thresholds. Thereafter, the output of each comparator 31 and 32 is grounded through a 1K Ohm resistor and then continues respectively to an ion output display alarm 15 or a balance alarm display 16. The back end of display 16 is coupled to the front end of display 15 through 1.2K Ohm resistor 29. The back end of display 15 goes to a +5 volt source through a 1.2K Ohm resistor 30. The structure is best understood by reference to Figure 2.

If the AC signal disappears from the HV leads, the ion output alarm occurs. If the AC signal disappears from the referencing leads, the ion balance alarm occurs. If the AC signal disappears from both leads, only the ion output alarm occurs.

It will be readily seen by one of ordinary skill in the art that the present invention fulfills all of the objects set forth above. After reading the foregoing specification, one of ordinary skill will be able to effect various changes, substitutions of equivalents and various other aspects of the invention as broadly disclosed herein. It is therefore intended that the protection granted hereon be limited only by the definition contained in the appended claims and equivalents thereof.

US 009930521

ARTICLE 34 AMDT 09/868842

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What is claimed is:

1. An ionizer monitor adapted to detect faults in an ionizer having high voltage circuits, said monitor comprising a sensing circuit (13, 14) able to be capacitively coupled (18, 19) to said high voltage circuits for detecting faults.

2. An ionizer monitor as in claim 1, wherein said ionizer has a reference circuit (9) or an emitter circuit (8) and said sensing circuit (13, 14) is able to be capacitively coupled (18, 19) to a reference circuit (9) or an emitter circuit (8) of said ionizer.

3. An ionizer monitor as in claim 1, wherein said ionizer monitor is usable in connection with a self-balancing ionizer.

4. An ionizer monitor as in claim 1, further comprising an alarm display coupled to said sensing circuit for indicating fault detection.

5. An ionizer monitor as in claim 1, further comprising a control circuit coupled to said sensing circuit for controlling said ionizer responsive to fault detection.

6. A method of detecting faults in high voltage circuits of an ionizer without affecting operation of said high voltage circuits, said method comprising the step of:

sensing the voltage of said high voltage circuits by capacitively coupling a sensing circuit with said high voltage circuit; and

comparing the sensed voltage with a threshold voltage.

ARTICLE 34 Amdt.

7. A method as in claim 6, further comprising the step of displaying an alarm if said sensed voltage is less than or equal to said threshold voltage.

8. A method as in claim 6, wherein said ionizer has a reference circuit (9) or an emitter circuit (8) and said sensing step includes capacitively coupling (13, 14) a sensing circuit (13, 14) with a reference circuit (9) or an emitter circuit (8).

9. A method as in claim 6, wherein said ionizer monitor is usable in connection with a self-balancing ionizer.

10. A method as in claim 6, further comprising the step of controlling said ionizer in response to said sensing step sensing a voltage less than or equal to said threshold voltage.

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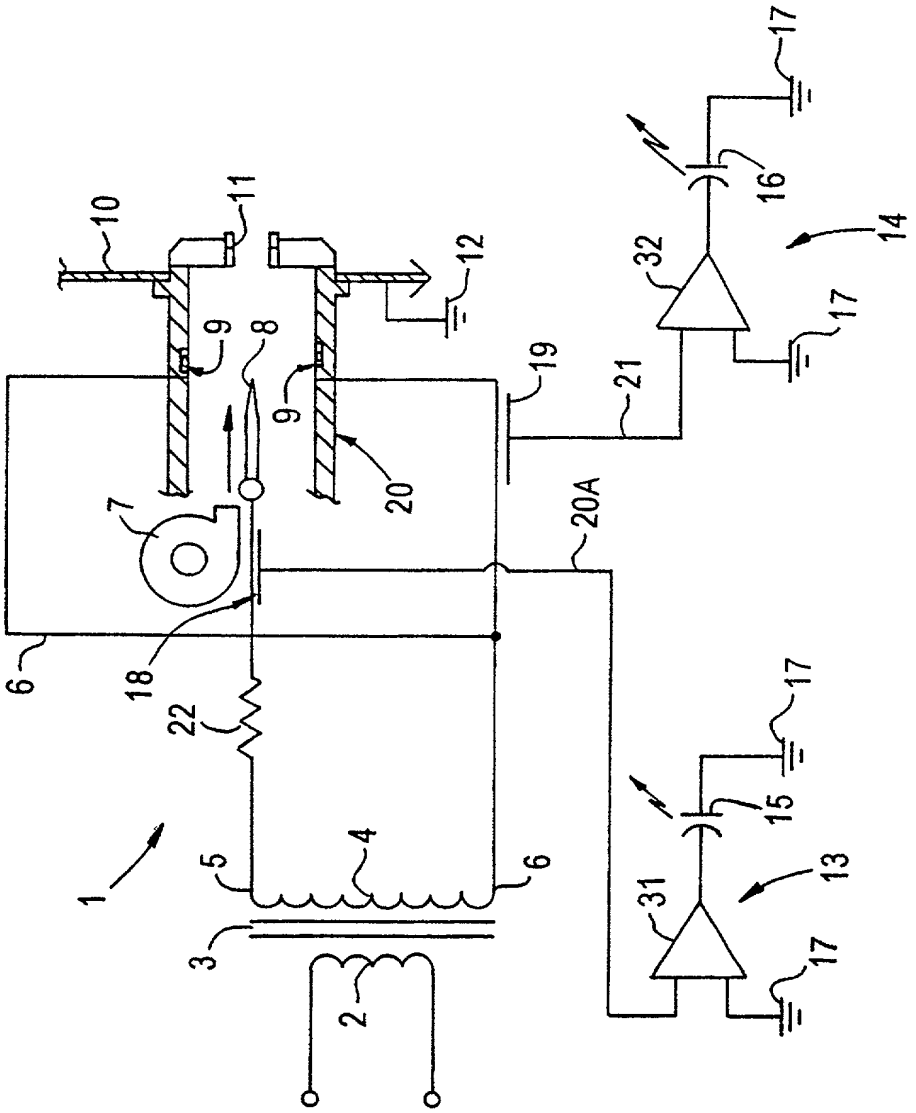

FIG. 1

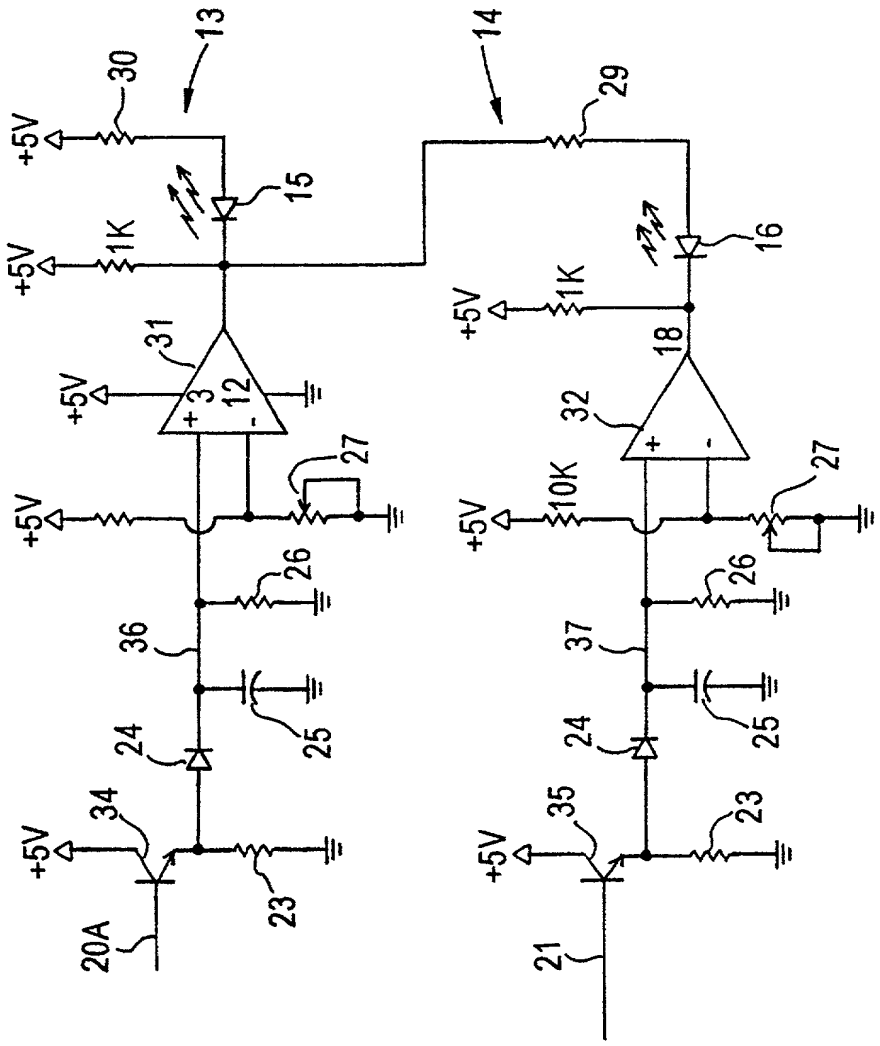
13
14
30
29
+5V
15
16
1K
31
18
32
12
27
10K
26
36
37
25
24
34
35
23
20A
21

FIG. 2

ATTORNEY DOCKET NO.: 713-258

DECLARATION FOR PATENT APPLICATION AND APPOINTMENT OF ATTORNEY

As a below-named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name; I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention (Design, if applicable) entitled: **SELF-BALANCING IONIZER MONITOR**

the specification of which (check one):

- ☐ is attached hereto.
- ☒ was filed on **21 June 2001** as Application Serial No. **09/868,842**.
- ☒ was filed on **22 December 1999** as International Application (PCT) No. **PCT/US99/30521**, and was amended on **6 February 2001** (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with *Title 37, Code of Federal Regulations, § 1.56*. I hereby claim foreign priority benefits under *Title 35, United States Code § 119* of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which the priority is claimed.

PRIOR FOREIGN APPLICATION(S)

NUMBER	COUNTRY	DAY/MONTH/YEAR FILED	PRIORITY CLAIMED
			☐ Yes ☐ No
			☐ Yes ☐ No

I hereby claim the benefit under *Title 35, United States Code, § 120* of any United States application(s) or PCT international application(s) designating The United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of *Title 35, United States Code, § 112*, I acknowledge the duty to disclose material information as defined in *Title 37, Code of Federal Regulations, § 1.56* which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

APPLICATION NUMBER	FILING DATE	STATUS (Patented, Pending or Abandoned)
60/113,211	**December 22, 1998**	**Pending**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine, or imprisonment, or both, under *Section 1001 of Title 18 of the United States Code*, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: I (We) hereby appoint as my (our) attorneys, with full powers of substitution and revocation, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Allan M. Lowe, Registration Number 19,641; Benjamin J. Hauptman, Registration Number 29,310; Michael G. Gilman, Registration Number 19,114; Kenneth M. Berner, Registration Number 37,093; and Randy A. Noranbrock, Registration Number 42,940.

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I hereby authorize the U.S. attorneys and agents named herein to accept and following instructions from ILLINOIS TOOL WORKS, INC. as to any actions to be taken in the U.S. Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the U.S. attorneys will be so notified by the undersigned.

☒ *See following page(s) for additional joint inventors.*

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DATE 8-6-01 August 6, 2001		*SIGNATURE* Richard D. Rodrigo	

DECLARATION FOR PATENT APPLICATION AND APPOINTMENT OF ATTORNEY

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City	*City*
State or Country *Zip*	*State or country* *Zip*
DATE	*SIGNATURE*

Full Name of Fourth Inventor	*Citizenship*
Residence Address - Street	*Post Office Address Street*
City	*City*
State or Country *Zip*	*State or country* *Zip*
DATE	*SIGNATURE*

Full Name of Fifth Inventor	*Citizenship*
Residence Address - Street	*Post Office Address Street*
City	*City*
State or Country *Zip*	*State or country* *Zip*
DATE	*SIGNATURE*

Full Name of Sixth Inventor	*Citizenship*
Residence Address - Street	*Post Office Address Street*
City	*City*
State or Country *Zip*	*State or country* *Zip*
DATE	*SIGNATURE*